Thermodynamics and Kinetics of the $Cu_{47}Ti_{34}Zr_{11}Ni_8$ Glass Forming Alloy

S.C. Glade and W.L. Johnson
Division of Engineering and Applied Sciences
California Institute of Technology
Pasadena, CA 91125 U.S.A.

The recent advent of multicomponent metallic glass forming alloys with improved stability in the undercooled liquid (compared to elemental and binary systems) allows the measurement of the thermo-physical properties in this regime. In this talk, we present specific heat capacity and viscosity data for $Cu_{47}Ti_{34}Zr_{11}Ni_8$, one of these alloys. The specific heat capacity of this alloy was measured in the crystalline solid, the amorphous solid, the supercooled liquid, and the equilibrium liquid. Differential scanning calorimetry and AC modulation calorimetry were used for these experiments. Using these data, the difference in the thermodynamic functions between the liquid and the crystalline solid (enthalpy, ΔH, entropy, ΔS, and Gibbs free energy, ΔG) can be calculated. The viscosity of the alloy was measured in the amorphous solid, the supercooled liquid, and the equilibrium liquid. Three point beam bending with a thermo-mechanical analyzer and a non-contact oscillating drop technique were the techniques used for these measurements. Both the thermodynamic data and the viscosity data show that $Cu_{47}Ti_{34}Zr_{11}Ni_8$ falls between good metallic glass formers (such as $Zr_{41.2}Ti_{13.8}Cu_{12.5}Ni_{10}Be_{22.5}$) and poorer metallic glasses (such as $Au_{77.8}Ge_{13.8}Si_{8.4}$). Using the thermodynamic data, the viscosity data can be described by the Adam-Gibbs theory, an entropy based theory of the relaxation behavior of supercooled liquids.